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Docket No.: GR 97 P 2065 D

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By: _____ Date: March 11, 2003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Before the Board of Patent Appeals and Interferences

Applicant : Wilhelm Frank et al.

Applic. No.: 09/639,962

Filed : August 16, 2000

Title : Piezoelectric Assembly

Examiner : Thomas M. Dougherty - Art Unit: 2834

BRIEF ON APPEAL

Hon. Commissioner of Patents and Trademarks,
Washington, D. C. 20231,

S i r :

This is an appeal from the final rejection in the Office action dated August 8, 2002, finally rejecting claims 1-9.

Appellants submit this *Brief on Appeal* in triplicate, including payment in the amount of $ 320.00 to cover the fee for filing the *Brief on Appeal*.

Real Party in Interest:

This application is assigned to *Siemens Aktiengesellschaft* of Munich, Germany. The assignment will be submitted for recordation upon the termination of this appeal.

Related Appeals and Interferences:

No related appeals or interference proceedings are currently pending which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

Status of Claims:

Claims 1-9 are rejected and are under appeal. No claims were cancelled.

Status of Amendments:

No claims were amended after the final Office action. A *Response under 37 CFR § 1.116* was filed on December 9, 2002. The Primary Examiner stated in an *Advisory Action* dated January 16, 2003 that the request for reconsideration has been considered but does not place the application in condition for allowance.

Summary of the Invention:

As stated in the first paragraph on page 1 of the specification of the instant application, the invention

relates to a piezoelectric assembly including a piezoelectric actuator prestressed and inserted into an elastic hollow body in an extension direction between a top and a bottom cover plate connected to the hollow body.

Appellants explained on page 7 of the specification, line 20, that, referring now to the figures of the drawings in detail and first, particularly, to Fig. 1 thereof, there is seen a piezoelectric actuator 1 which includes a plurality of individual piezoelectric elements stacked one upon the other. The piezoelectric actuator 1 is introduced into a hollow body, mould, shape or form 2. The hollow body or mould 2 is, for example, a sleeve with an annular cross section or a rectangular-section tube profile. The hollow body or mould 2 is preferably matched in shape to the shape of the piezoelectric actuator 1. A bottom end of the piezoelectric actuator 1 rests on a bottom cover plate 4, which is force-lockingly and/or form-lockingly connected to the hollow body or mould 2. In this illustrative embodiment, the bottom cover plate 4 is form-lockingly connected to the hollow body or mould 2 by a weld 5. A form-locking connection is one which connects two elements together due to the shape of the elements themselves, as opposed to a force-locking connection, which locks the elements together by force external to the elements.

Appellants outlined on page 8 of the specification, line 14, that a top end of the piezoelectric actuator 1 rests against an upper cover plate 3, which is likewise form-lockingly and/or force-lockingly connected to the hollow body or mould 2. In this illustrative embodiment, the top cover plate 3 is form-lockingly connected to the hollow body or mould 2 by a weld 5.

It is further outlined on page 8 of the specification, line 20, that the top cover plate 3 has passages 7 through which contact pins 6 of the piezoelectric actuator are passed. The contact pins 6 are used to make the piezoelectric actuator capable of being activated for extension or expansion. The piezoelectric actuator 1 is prestressed with a defined force by the hollow body or mould 2 and the bottom and top cover plates 3, 4 so as to resist deflection. In order to achieve this, the hollow body or mould 2 is manufactured from a correspondingly elastic material. Preferred materials are those with a low modulus of elasticity, such as a copper-beryllium alloy ($CuBe_2$) and/or those with a high strength characteristic, such as spring steel.

Appellants outlined on page 9 of the specification, line 7, that a further improvement in the elastic properties of the

hollow body or mould 2 is achieved by making apertures in the hollow body or mould 2. Different shapes of the apertures are illustrated in greater detail in Figs. 3 to 7.

It is further outlined on page 9 of the specification, line 12, that Fig. 2 shows a prestressed piezoelectric actuator 1 which, as in Fig. 1, is clamped between a top cover plate and a bottom cover plate 3, 4 by a hollow body or mould 2. In this example, the connection between the hollow body or mould 2 and the top and bottom cover plates 3, 4 is effected through the use of flanges 8. For this purpose, the top and bottom cover plates 3, 4 preferably have recesses 26 into which respective flanged top and bottom edge regions of the hollow body or mould 2 engage. In a simple embodiment, no recesses 26 are provided and the top and bottom edge regions are simply flanged around the top and bottom edges of the top and bottom cover plates 3, 4.

Appellants stated in the last paragraph on page 9 of the specification, starting at line 25, that a significant advantage of the structural units illustrated in Fig. 1 and Fig. 2, which are constructed of the top and bottom cover plates 3, 4, the hollow body or mould 2 and the piezoelectric actuator 1, is that the prestress of the piezoelectric actuator is permanently fixed through the use of the fixed

connection to the hollow body or mould 2. This means that there is no need for readjustment during the entire service life of the actuator.

Appellants explained on page 10 of the specification, line 8, that the piezoelectric actuator 1, the hollow body or mould 2 and the top and bottom cover plates 3, 4 form a compact structural unit which can be transported without problems and can be installed in a corresponding final control element, in particular an injection valve, in a simple operation. The structural unit 1, 2, 3, 4 can be removed from the final control element without any change in the prestress of the piezoelectric actuator 1. In addition, the structural unit can be manufactured at relatively reasonable cost.

Appellants further explained on page 10 of the specification, line 18, that Fig. 3 shows a hollow body or mould 2 that forms a cylindrical sleeve in which transverse slots 10 are made perpendicularly to the longitudinal axis. The number and length of the transverse slots 10 are such that the elasticity of the hollow body or mould 2 is matched to the desired manner of operation of the prestressed piezoelectric actuator according to Figs. 1 and 2.

Appellants stated on page 11 of the specification, line 1, that Fig. 4 shows a hollow body or mould 2 that forms a cylindrical sleeve in which oblique slots 11 are made obliquely to the longitudinal axis of the hollow body or mould 2.

Appellants further stated on page 11 of the specification, line 5, that Fig. 5 shows a hollow body or mould 2 that forms a cylindrical sleeve in which an oblique aperture 12 running in a spiral around the hollow body or mould 2 is made. In this case, at least part of the hollow body or mould 2 is in the form of a cylindrical spiral.

It is also explained on page 11 of the specification, line 11, that Fig. 6 shows a hollow body or mould 2 that forms a cylindrical sleeve in which a plurality of slots 13 disposed parallel to one another and in a spiral relative to the longitudinal axis of the hollow body or mould 2 are made. Due to the slots 13, at least part of the hollow body or mould 2 forms a plurality of cylindrical spring elements in the form of spirals.

Appellants further described on page 11 of the specification, line 18, that Fig. 7 shows a hollow body or mould 2 that is

constructed as a cylindrical sleeve in which circular apertures 14 are made.

Appellants set forth in the last paragraph on page 11 of the specification, starting at line 221, that the number and geometry of the apertures and slots in Figs. 3 to 7 are chosen in such a way that the elasticity of the hollow body or mould 2 in the longitudinal direction, i.e. parallel to the direction of deflection of the piezoelectric actuator 1, is matched to the desired manner of operation of the piezoelectric actuator 1.

Appellants explained on page 12 of the specification, line 1, that the hollow body or moulds 2 illustrated in Figs. 3 to 7 are preferably constructed as thin-walled hollow body or moulds which are produced from a simple, thin-walled and preferably drawn tube.

Appellants further explained on page 12 of the specification, line 6, that an advantageous method for producing the hollow body 2 includes making apertures and/or slots in a plate of defined thickness and defined dimensions in a first operation. The shape of the plate offers the advantage of making the plate readily accessible for the introduction of the apertures, and the apertures can be made in a wide variety of

geometries, numbers and configurations, for example by inexpensive punching.

It is also set forth on page 12 of the specification, line 15, that an edge region of an aperture is preferably slightly plastically deformed, resulting in hardening of the plate due to an introduced internal compressive stress. A corresponding hardening can also be achieved, for example, by shot peening the edge regions of the aperture.

Appellants described in the last paragraph on page 12 of the specification, line 21, that this has a highly strength-enhancing effect, particularly in the case of dynamic loading of the hollow body or mould 2. This is achieved, for example, if the punch with which the apertures are made in the plate is widened to a larger cross section, after the punching cross section, as seen in the direction of punching. As a result, the desired aperture is punched out of the plate first and then the edge region of the aperture is compacted. This introduces an internal compressive stress into the edge region of the aperture which results in good fatigue strength. During this process, the thickness of the edge is preferably increased. The edge may be bent slightly out of the plane of the plate, depending on the type of working. This can, for example, be an indication of compaction of the edge.

Appellants explained on page 13 of the specification, line 10, that the plate is then formed to provide the desired hollow body or mould 2 and fixed in the hollow body or mould 2 through the use of a weld. A seam which is formed in this process is preferably welded with a laser. Non-uniformities in the weld are eliminated by a heat treatment.

Appellants further explained on page 13 of the specification, line 16m, that, as an alternative, it is also possible for the tubular shape to be fixed by connecting the hollow body or mould 2 to the top and bottom cover plates 3, 4. In this case, butting edges, which are usually welded, are not connected to one another. The butting edges illustrated in Figs. 8 to 11, which form seams 15, 17, 16, 18, are thus not connected to one another in this illustrative embodiment. An advantageous distribution of the spring and pressure forces is thereby achieved.

Appellants outlined on page 14 of the specification, line 1, that Figs. 8 to 11 show various forms of seams 15, 16, 17, 18 which connect two butting edges of a formed plate and thus fix the hollow body or mould 2. Fig. 8 shows an oblique seam 15 disposed obliquely to the longitudinal axis of the sleeve shape 2. Fig. 9 shows a wavy seam 17, which is disposed

symmetrically with respect to the longitudinal direction of the hollow body or mould 2 and is disposed in the form of a sine wave parallel to the longitudinal direction of the sleeve shape 2. Fig. 10 shows a longitudinal seam 16 disposed parallel to the longitudinal direction of the hollow body or mould 2. Fig. 11 shows a crisscross seam 18 disposed symmetrically with respect to the longitudinal axis of the hollow body or mould 2. The crisscross seam 18 is disposed in the form of a zigzag line in the longitudinal direction relative to the hollow body or mould 2. The seams 15, 16, 17, 18 are preferably welded.

It is set forth in the last paragraph on page 14 of the specification, line 18, that the spring rate of the hollow body or mould 2 can be adjusted within wide limits through the use of the following parameters: inside and outside diameter of the sleeve mould, wall thickness, material with suitable modulus of elasticity, number of apertures, geometry of the apertures (holes, grooves, spiral grooves, etc.), and configuration of the apertures (horizontally, vertically, obliquely and, in the case of spiral grooves: slope, number of flights, groove width, etc.).

Appellants outlined on page 15 of the specification, line 1, that the apertures are, for example, made by drilling, punching, milling, erosion or electrochemical methods.

Appellants also outlined on page 15 of the specification, line 4, that Fig. 12 shows an assembly configuration through the use of which a piezoelectric actuator 1 is installed in a sleeve-shaped hollow body or mould 2 with a precisely defined force. For this purpose, one end of the hollow body or mould 2 is form-lockingly and/or force-lockingly connected to a top cover plate 3 having passages 7. The hollow body or mould 2 has a bearing edge 24 which points radially outward at another end. The hollow body or mould 2 is inserted, top cover plate 3 first, into an assembly fixture 20. The assembly fixture 20 has an assembly recess 21 which matches the cross section of the hollow body or mould 2 in such a way that the hollow body or mould 2 can be inserted into the assembly recess 21 with the bearing edge 24 supported in a bearing region 27 of the assembly fixture 20. A piezoelectric actuator 1 is then inserted, contact pins 6 at a front end first, into the hollow body or mould 2. A bottom cover plate 4 is then inserted into the hollow body or mould 2 and pressed into the hollow body or mould 2 with a defined force by an assembly device 23 using a punch 22, so that the hollow body or mould 2 is thereby elongated elastically.

It is described in the last paragraph on page 15 of the specification, line 25, that the defined force corresponds to the desired prestress of the piezoelectric actuator 1. While maintaining the force, the bottom cover plate 4 is then force-lockingly and/or form-lockingly connected to the hollow body or mould 2, preferably by being welded to it. This connects the actuator to the hollow body in the vicinity of the rear end of the actuator and fixes the prestress of the piezoelectric actuator 1.

Appellants outlined on page 16 of the specification, line 7, that Fig. 13 shows a second variant of the assembly configuration. In contrast to the configuration in Fig. 12, the hollow body or mould 2 remains unloaded during assembly, and the bent-over bearing edge 27 shown in Fig. 12 can be omitted. For this purpose, one end of the hollow body or mould is form-lockingly and/or force-lockingly connected to the top cover plate 3 having the passages 7, the piezoelectric actuator 1 is introduced into the hollow body or mould 2 and, as shown in Fig. 13, inserted with the contact pins of the piezoelectric actuator 1 entering into depressions that are provided for this purpose in a baseplate 19. The bottom cover plate 4 is then placed on the actuator 1, pressed into the hollow body or mould through the use of a punch 22 of an

assembly fixture 20, and then form-lockingly and/or force-lockingly connected to this hollow body or mould, preferably by being welded to it. The force which is used for pressing in compresses only the piezoelectric actuator 1 and the cover plates 3, 4. After the relief of the load on the assembly fixture 20, the actuator 1 expands and, in the process, stresses the hollow body or mould 2. The force used for pressing in must be calculated, while taking the stiffnesses of the actuator 1 and the hollow body or mould 2 into account, in such a way that a defined prestressing force is established after the relief of the load on the system.

It is set forth in the last paragraph of the specification, starting at line 6 on page 17, that length tolerances of the piezoelectric actuator 1 which are inherent in production can preferably be compensated for by grinding the bottom cover plate 4. Grinding can furthermore be employed to correct any deviation from parallelism of the end surfaces of the piezoelectric actuator 1. For this purpose, the bottom cover plate 4 should be ground at a corresponding angle.

References Cited:

U.S. Patent No. 4,354,131 (*Kaji*), dated October 12, 1982;

U.S. Patent No. 4,943,004 (*Takahashi*), dated July 24, 1990;

U.S. Patent No. 4,958,100 (*Crawley et al.*), dated September 18, 1990;

U.S. Patent No. 5,239,223 (*Miyoshi*), dated August 24, 1993.

Patent Abstracts of Japan No. 55-134990 (*Onishi*).

Issues

1. Whether or not claims 1 and 6-9 are obvious over *Miyoshi* in view of *Crawley et al.* under 35 U.S.C. §103.

2. Whether or not claims 1, 2, and 5 are obvious over *Onishi* in view of *Crawley et al.* under 35 U.S.C. §103.

3. Whether or not claim 3 is obvious over *Miyoshi* and *Crawley et al.*, or *Onishi* and *Crawley et al.* in view of *Kaji* under 35 U.S.C. §103.

4. Whether or not claim 4 is obvious over *Miyoshi* and *Crawley et al.* in view of *Takahashi* and *Onishi* under 35 U.S.C. § 103.

Grouping of Claims:

Claim 1 is independent. Claims 2-9 depend on claim 1. The patentability of dependent claims 2-9 are not separately argued. Therefore, dependent claims 2-9 stand or fall with independent claim 1.

Arguments:

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

> an elastic hollow body with an elasticity;
>
> a top cover plate connected to said hollow body by one of welding and flanging, and a bottom cover plate connected to said hollow body; and
>
> a piezoelectric actuator with a ***permanent and fixed*** prestress, said piezoelectric actuator being contacted by said hollow body, said top cover plate, and said bottom cover plate.

Whether or not claim 1 is obvious over *Miyoshi* in view of *Crawley et al*.

Clearly, as can be seen from the drawing in *Miyoshi*, *Miyoshi* does not show a prestressed piezoelectric actuator being ***contacted*** by said ***hollow body***, said top cover plate, and said bottom cover plate, as recited in claim 1 of the instant application. The Examiner applied the secondary reference *Crawley et al*. for showing a "piezoelectric actuator being contacted by said hollow body". As admitted by the Examiner in the first paragraph on page 3 of the final Office action,

"Crawley et al. don't show connection of the hollow body by one of welding and flanging."

In order to establish a *prima facie* case of obviousness by modifying or combining reference teachings, MPEP § 2143 requires that:

- there must be ***some suggestion or motivation*** to … combine the references in the prior art;
- there must be a ***reasonable expectation of success*** to be found in the prior art; and
- the prior art references must teach or suggest all the claim limitations.

It is believed that there is no ***suggestion or motivation*** with ***reasonable expectation of success*** in the prior art for combining *Miyoshi* and *Crawley et al.* to obtain a piezoelectric actuator with a permanent and fixed prestress contacted by a hollow body and a top cover plate connected to the hollow body by one of welding and flanging, as recited in the claims.

It is accordingly believed to be clear that *Miyoshi* in view of *Crawley et al.* do not suggest the features of claim 1.

Whether or not claim 1 is obvious over *Onishi* in view of *Crawley et al.*

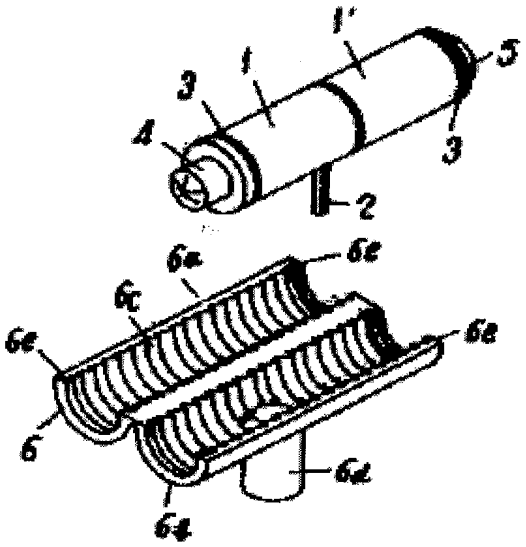
As admitted by the Examiner in the first paragraph on page 3 of the final Office action, "Crawley et al. don't show connection of the hollow body by one of welding and flanging."

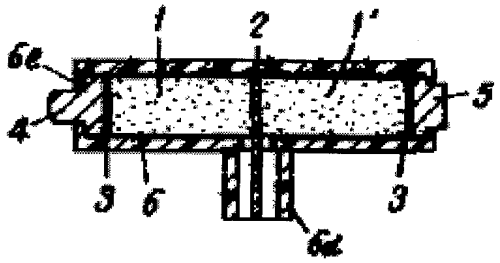
In the second paragraph on page 3 of the final Office action, the Examiner stated that "Onishi shows (figs 2 and 3) a piezoelectric ... assembly, comprising: ... a top cover plate (4) connected to said hollow body by one of welding and flanging (6e)".

The English Abstract of *Onishi* states that:

> An insulating case 6 is formed in such a manner that it is joined at its circumferential end section and that two semi-cylindrical bodies which are free-to-turn centering on the joined section are butt-on welded to each other. Inside surfaces of the semi-cylindrical bodies 6a and 6b are provided with protrudent coils 6c to be pressure-attached onto outside surface of piezoelectric elements 1 and 1', center section of the semi-cylindrical body 6b is provided with an intermediate terminal 2 take-out cylinder 6d, and its axial end section is provided with a step section 6e for engagement between an impact-receiving metallic object 4 and a receiving body 5, and then, force to press the piezoelectric elements 1 and 1' is applied to the metallic object 4 and the receiving body 5 by the step section 6e. As it is possible, in this mechanism, to divide outside surface of the piezoelectric elements into many steps by the protrudent coils 6e and to prevent thereby internal discharge, necessity of impregnation of insulating resin becomes eliminated and therefore fabrication becomes easier.

The drawings of *Onishi* are re-produced below.





As far as Appellants were able to ascertain, there is no disclosure in *Onishi* regarding the end plates 3 and 5 and how these end plates are fixed to the insulating case 6. The only mentioning of welding in *Onishi* is in regard to the insulating case 6 which is formed by "butt-on" welding of two semi-cylindrical bodies. Consequently - similarly to *Crawley et al.* - *Onishi* do not disclose (or suggest) "a top cover plate connected to said hollow body by one of welding and flanging", as recited in claim 1.

Since neither *Onishi* nor *Crawley et al.* show or suggest a top cover or top plate connected to the hollow body by welding or flanging, claim 1 is believed to be non-obvious over *Onishi* in view of *Crawley et al.*.

The honorable Board is therefore respectfully urged to reverse the final rejection of the Primary Examiner.

Respectfully submitted,

For Appellants

MN/bb

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Appendix - Appealed Claims:

1. A piezoelectric assembly, comprising:

an elastic hollow body with an elasticity;

a top cover plate connected to said hollow body by one of welding and flanging, and a bottom cover plate connected to said hollow body; and

a piezoelectric actuator with a permanent and fixed prestress, said piezoelectric actuator being contacted by said hollow body, said top cover plate, and said bottom cover plate.

2. The piezoelectric assembly according to claim 1, wherein said hollow body has a given length, two butting edges and at least one connecting seam connecting said two butting edges to one another and extending entirely over said given length.

3. The piezoelectric assembly according to claim 1, wherein said hollow body has a longitudinal direction and two butting edges associated with one another and disposed in said longitudinal direction, said butting edges not being connected to one another.

4. The piezoelectric assembly according to claim 1, wherein said hollow body has apertures at least partially determining said elasticity of said hollow body.

5. The piezoelectric assembly according to claim 1, wherein said hollow body is made of at least one plate formed into said hollow body and then fixed by at least one connecting seam.

6. The piezoelectric assembly according to claim 1, wherein said elasticity of said hollow body is matched to a desired manner of operation of said piezoelectric assembly.

7. The piezoelectric assembly according to claim 1, wherein said piezoelectric actuator has an extension direction and is inserted into said hollow body in said extension direction between said cover plates for prestressing said actuator.

8. The piezoelectric assembly according to claim 1, wherein said prestress of said piezoelectric actuator corresponds with said elasticity of said hollow body.

9. The piezoelectric assembly according to claim 1, wherein said piezoelectric actuator has a shape, and said hollow body is matched in shape to said shape of said piezoelectric actuator.